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ABSTRACT

This book provides practical ideas and information for volunteer tutors and teachers about teaching numeracy, as well as a reference section that concentrates on specific content areas. The first part of the book considers teaching techniques, the planning and presentation of numeracy material, evaluation of progress, reinforcement of newly learned concepts, working with students of a wide range of ability, working with students who also have literacy problems, and helping those who require an immediate solution to a specific problem. The second part is devoted to the concepts and skills students may need to solve problems in day-to-day living and to pass different types of tests. It should serve as a reference for the tutor. Information and teaching suggestions are provided for these concepts: estimation, place value, addition, subtraction, multiplication, division, fractions, decimals, percentages, and measurement. (YLB)

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An Introduction to Numeracy Teaching

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Adult Literacy & Basic Skills Unit

Foreword

I hope that 'An Introduction to Numeracy Teaching' will be a useful resource for everyone involved in helping adults improve their basic maths. It aims to provide some concise and clear guidance for volunteer tutors and teachers about teaching numeracy as well as a reference section that concentrates on specific content areas.

'An Introduction to Numeracy Teaching' is not intended to be an exhaustive or comprehensive handbook but rather intends to provide an introduction that can be built on as experience is gained. As is our normal practice this book was written by a group of practitioners convened by the Unit and edited and published by ALBSU. Finally my thanks are due to Pamela Jones and Sandy Warren, who were responsible for the co-ordination and production of this book.

Alan Wells, Director
Adult Literacy and Basic Skills Unit

The Group

Keith Connor
Head of Numeracy, Islington Institute, ILEA

Anne Dodd
Lecturer in Basic Numeracy and Social and Life Skills at Dacorum College, Hemel Hempstead

Deryn Holland
Co-ordinator for ABE, Wycombe, Bucks.

Margaret Moss
Numeracy Organiser, Reading Adult College, Berkshire

Janet Swinney
Advisory Tutor for Adult Learning Difficulties, Thurrock and Basildon Areas, Essex

Janet Ward
Adult Literacy Organiser and Numeracy Tutor in East Sussex

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Note: For the purpose of clarity and simplicity, 'he' has been used throughout when referring to students and 'she' when referring to tutors.

Introduction

'An Introduction to Numeracy Teaching' aims to provide a collection of practical ideas and information for numeracy tutors and organisers and attempts to answer some of the questions which tutors, both new and experienced, may have asked themselves.

Students come for help with numeracy for a wide variety of reasons. Some may have difficulty with problems in everyday life. Some may wish to learn or revise the basic arithmetic operations required to pass tests for courses or to obtain the necessary qualifications for jobs. Others would like to be able to help their children with mathematics. Students' numerical ability can range between people who have difficulty with the simplest addition to others who require a revision of skills before they join a pre 'O' level course. Some numeracy students may also have literacy problems and there is a section in the book which deals specifically with these additional difficulties.

The first part of the book considers teaching techniques, the planning and presentation of numeracy material, working with groups of students of a wide range of ability, and helping those who require an immediate solution to a specific problem. The second part is devoted entirely to the concepts and skills students may need to solve problems in day to day living and to pass different types of tests and should serve as a reference for the tutor. It needs to be realised, however, that many skills are of little use if students are unable to apply them to problems involving numeracy and that a page of 'ticks' for correctly worked division is of little use unless the student can apply this skill to discover, for example, how much he is paying for potatoes at 5 lbs. for 35p, as compared with 1 lb. for 9p.

Although students request help with such a wide variety of numeracy problems, the first task is to give students the confidence to master their difficulties and so start to overcome their often deep-rooted fear of 'maths' or 'figures'. If this can be accomplished, many students discover their problems are far less intractable than they anticipated and, at least in some instances, find numeracy can be an interesting and even enjoyable experience.

PART I

The First Meeting

Meeting a student for the first time may appear to be straightforward, but there are a number of important factors to consider as the first meeting may well be the major influence on a student's decision to continue to want to improve his numeracy. He may have unpleasant memories of maths at school. Perhaps he is convinced he is a failure and has no confidence in his abilities. Again, it should be stressed that his first need may be some confidence in himself rather than a knowledge of numerical skills and concepts.

Many students find it difficult to make the decision to come for help. For some a sense of unease or fear, even bordering on panic, seems to arise where figures and calculations are concerned; this, combined with the natural apprehension of an interview, often produces a feeling of extreme nervousness. If the interviewer is aware of this, she will understand the student's feelings and seek to build confidence from the beginning. The interviewer may spend the first few minutes putting the student at his ease and through casual conversation, find some area or subject in which he is skilled or knowledgeable. The interviewer may then begin to ask why the student has come and if he has any particular difficulties. If the student is to be helped as effectively and swiftly as possible, it is important to discover his strengths as well as his weaknesses.

There may be five minutes or an hour for this initial meeting, but however much time is available, no tutor or organiser will be able to discover everything in one interview. The main aims should be to give the student the confidence to return, to provide information about the help that can be offered and for the interviewer to have some idea of the reasons which have caused the student to make the initial contact.

Some General Points

1. Make the setting comfortable and informal
Easy chairs, quiet area.

2. Be friendly
Encourage and help him to relax.

3. Fill in the background of the scheme
Explain how numeracy provision is organised group or one-to-one tuition, size of group, some idea of the help given to other students, fees (if any), times and places where tuition is given.

4. Be a good listener
Let the student talk; often after some initial hesitation, he will want to tell you where things went wrong, what strengths and weaknesses he has and why it's important to learn now. Try not to interrupt the flow, but return to particular points later if necessary.

5. Pick up on his strengths
Try to find areas the student is good at and be positive about these.

6. Emphasise the student's involvement in his own learning
It is important that the student realises that his needs and objectives are of paramount importance.

7. Don't give the student a formal test
Find out as soon as possible what the student wants, decide whether it is realistic and begin to prepare with him an agreed programme of learning. The interviewer should try to discover as far as possible how the student copes with mathematical problems in this first session, but a formal test is not necessary as a good listener can obtain a fair amount of information about a student's abilities just from conversation.

8. Prepare the student for the first lesson
Remember, if the student doesn't feel at ease in this initial session, he may not want to come again. Don't brush aside the things that are worrying the student but try to provide reassurance.

9. Make a list of starting points for future lessons
Jointly agree a number of mathematical concepts or skills that might be looked at in the first few sessions.

10. Criteria for success
Stress the extent to which the criteria for success should be the student's rather than the tutor's. If a student wants no more than to know how to operate a calculator, learns this, then leaves satisfied, that is success.

11. Students cannot always be offered help
Some students may be capable of or require more advanced tuition than the scheme can offer. Others may live too far from the centre to come regularly but could go to a scheme nearer home or work. It is useful, therefore, to have up-to-date information about other numeracy classes or groups and a note of any other local centres. It may be possible to contact these for the student immediately and if he wishes arrange an appointment.

12. The student is interviewing the tutor as well
Don't avoid the student's questions; be honest.

13. This is only the first of many meetings
Don't push for information, it's impolite and very off-putting. Make a note of things that might be followed up by the tutor.

14. Make notes
Unless the student objects, always make notes. Explain why you are taking notes and how they will be used. Seek permission with a phrase like 'Do you mind if I make notes?'

At the end of the session, check through the notes with the student, hopefully this will be the start of a continuing joint assessment.

15. Background information
It is important to note details such as the times the student is available. For example, he may work at night or be a shift worker, have family commitments, or wish to keep the fact that he is receiving help with numeracy from friends and relations. If the interviewer is an organiser, it is important that with the student's permission details are passed on to his tutor.

Some areas of information that might be considered during the first meeting

This is not a checklist to be followed, but an ideas list from which to choose; depending on circumstances some information will be more crucial than others and may need to be expanded at some time in the future.

1. Name and Address, etc: Carefully check the name of the student and his address, relevant telephone number, etc.

2. Date of Initial Meeting: Make sure the date of the initial meeting, where it happened and the starting date for lessons is recorded.

3. The Reason the Student Comes: Many people are not very numerate and it may be a big decision for a student to come to numeracy classes. There is often a fairly clear reason for 'taking the plunge' at a particular time so try to find out what it is, since it is likely to influence the whole of the learning programme. Areas of difficulty might include:

a) Employment or Unemployment – coping better with a job, trying for a different job or just getting a job in the first place

b) Helping Children – often a background or assumed reason

c) General 'Improvement' – often linked to a feeling of greater independence, not wanting to rely on other people, or perhaps just finding the time to learn.

The reasons for coming are obviously of paramount importance in influencing the student's expectations and aspirations. How this area is explored very much depends on the tutor and the student so it's as well to start with fairly straightforward questions which can be related to reasons for coming. For example, if there are problems coping with maths at work, a question like 'can you think of any time in the last two weeks at work when you wished your maths had been better?', may be helpful.

Beyond this, it is sometimes useful to choose a few examples of situations involving mathematical knowledge and ask the student some of the following questions. The list below is neither exhaustive nor in any order and relates to practical areas involving numeracy. It is most unlikely the student would need to be asked more than two or three questions, in fact, just one question might encourage the student to talk about his needs and wishes. Try to select everyday problems that are realistic.

Would you be able to . . . ? and if not, would you like to be able to . . . ?

- ☐ measure a window for curtains?
- ☐ work out how many tiles or paving stones you would need to cover a floor/patio?
- ☐ use a calculator?
- ☐ know if your change is correct?
- ☐ work out and add on VAT?
- ☐ check an electricity bill?
- ☐ work out how many plants you would need to fill a set area of ground?
- ☐ measure out the quantities in a recipe?
- ☐ keep appointments several weeks in advance?
- ☐ use a bus/train/boat/plane timetable?
- ☐ work out betting odds on horses/dogs?
- ☐ follow a dressmaking pattern, cut the material etc?

Making a Start

Making a start is always difficult, no matter how experienced the tutor may be. A whole range of factors will be brought to bear on the work the tutor and student have decided to begin with including:

- ☐ the type of group the student may join, including the arrangement of chairs and tables
- ☐ the type of learning the tutor feels confident about setting up and working through
- ☐ the materials available
- ☐ the number of students in the group
- ☐ the range of ability and 'personalities' of the students.

Although it is not possible to explain exactly where to start with each individual student, there are some things worth bearing in mind.

Make sure that the tutor and the student agree about where to start

The section on initial assessment emphasised the need for a joint agreement on a possible starting point and it is vital that the tutor and student agree about these initial activities. If the tutor aims at a student centred approach, then there are very roughly three types of situation in which the tutor may be involved.

1. The tutor and the student agree on the starting point
Sometimes student and tutor can agree immediately about an area of work; this is often the case where a student has limited but realistic objectives. For example, a student may only want to make some shelves for the kitchen. However, the idea of measuring up, etc. is too much and he needs some help to work it out.

2. The student has overestimated his abilities
There are many variations of 'well, it's just those fractions, that I want to start on'. In the majority of cases the tutor is involved in the delicate task of negotiating a more basic starting point and how this is done depends very much on the personality of the student and the tutor.

Often it is tactful to find out early on just what the student can do and work from this point outwards very gradually at first, making sure that the learning activities are likely to have a reasonable success rate.

3. The student has underestimated his abilities

The student who says 'I must go back to basics' is often easier to deal with than the one who overestimates his abilities. Underestimation of ability usually stems from a lack of confidence, which may or may not be easy to remedy. One reason for this feeling is that the student learnt or half-learnt a series of skills at school, often with minimal knowledge of how to apply these skills in real life. He may have a half-remembered, half-understood concept which can be built upon, although sometimes these memories are so confused they may have to be completely reassembled.

If students do underestimate their ability, it may be best to start with something relatively simple and pick up on their strong points so as to build up confidence.

Evaluating Progress

People who are effective learners are generally well organised. They:

a) know what it is they want to learn

b) work out some strategies for getting there

c) review the situation every now and then to see how far they are from achieving (a) and whether or not their strategies are working.

If students are to be effective learners, they must be encouraged to evaluate their own progress; any evaluative procedure should include the student as well as the tutor. Some students may find this idea difficult to accept, usually because of the traditional distinction in our education system between the roles of learner and teacher and it may not occur to them that their own judgement of whether they are doing well, badly or indifferently is the most important. Unfortunately old habits die hard, so it is up to the tutor to introduce the concept of evaluation early on and to explain to the student why it is important for him to be involved in it. One way to start is to ask the student what he would have to do to

prove to himself that he had made some progress and to use this as a basis for evaluation later on.

In the process of evaluation the tutor should act as an enabler rather than as a teacher, providing contexts within which the student can try out his learning and the kind of support which enables him to make an assessment of his performance.

Activities

There are a number of activities which the tutor can set up to assist with evaluation, some of which are outlined below.

Explaining to someone else:

Either —

a) the student explains to another student, less informed than himself, some process he feels he has mastered. He can do this either orally or in writing. The measure of his success is whether or not the listener grasps the point. (The tutor needs to check this for the safety of the second student).

or

b) the student explains to the tutor or a student better informed than himself who says whether or not the explanation is acceptable.

Performance in a simulated situation:

Simulations can be used in two ways —

a) to rehearse an event in real-life which has been causing problems. Suppose, for instance, that a student is anxious about going to the bank to pay money into his account and has been working on how to overcome his difficulties (filling in deposit slips, doing addition of money calculations and so on). A simulated situation in the group with one student as the bank cashier and the other as a customer provides the student with an opportunity to find out how far he has moved towards being able to do it in real-life.

b) to assess the transferability of learning. Skills learned for one situation (e.g. papering the living room) can be tried out in another (e.g. shopping for curtain material).

The advantage of simulation is that it involves some of the stress of real-life without the risk of humiliation and failure.

Performance in real-life:

This can be used in the same ways as the simulation described above. Performing successfully in real-life is the ultimate proof that you have achieved something, although it lacks the safety-net of simulation. However, if tutor and student have thought carefully about using this as an evaluation activity, there should be little risk.

Making a worksheet for someone else:

The student makes a worksheet on a subject he feels he has mastered for another student who is at the same stage or more advanced than himself. Whether or not the second student can complete the worksheet successfully will depend upon a number of factors and what he says about its clarity or use will give the first student some idea of his own progress.

After the Activity - Looking Inwards

Introspection is the basis of all evaluation. Whatever the activity, there must always be the opportunity afterwards for the student to ask himself:

1) How did I *do*?
2) How does this compare with other times when I have done the same thing?
3) How did I *feel* about doing it?
4) How does this compare with how I used to feel?

Questions 3 and 4 are just as important as questions 1 and 2. Many people pass their driving tests but don't feel confident to drive. It is only after a year or two's experience of getting successfully from A to B that an individual realises he has relaxed and is beginning to feel competent and it is a similar improvement in self-confidence that both student and tutor need to be looking for. Sometimes, chance remarks made by the student will indicate that there has been a change of perspective, e.g. "I make them wait now while I work it out", but by including questions 3 and 4 in any follow-up to an activity, the tutor makes certain that the student is aware of his own changing attitudes.

Looking Inwards - A Public or Private Occupation?

Some students, especially those who haven't been attending classes for long, are shy about discussing how they're getting on in the presence of anyone other than the tutor. They are still all too aware of the experiences they have outside the group. However, where a group has been

meeting for some time and its members know one another, there is no reason why some activities should not be undertaken on a group basis. The questions outlined above may provide a useful basis for structuring the conversation.

Group discussion has the following advantages:

a) The student can benefit from the experience of other members of the group. The group is an ideal place to discuss learning strategies.

b) The student finds that there are other people he can share his hopes, doubts and fears with.

c) He gains an insight into other people's capabilities as well as his own. This operates on the level of personality as well as mathematical ability and in a long established group, this should be a constructive rather than a threatening experience.

d) Group discussion can bring out into the open all these processes which in the past have been an unspoken part of the teaching experience. Traditionally the learner has been treated as a passive consumer. To become truly independent, the student must be better informed and contribute actively to his own learning.

Frequency of Evaluation

It is a good idea to allocate time for evaluation in the same way that one allocates time for other activities so that it is given its due status, and gradually students come to see it as a necessary and regular part of their work. How often this kind of slot should be featured depends on the kind of timetable students are following – whether they are full-time or part-time. It is up to the tutor to experiment and find out what is most appropriate.

Keeping a Record

Record-keeping eases the process of remembering. If the student is responsible for evaluating his own progress, then he ought also to be responsible for keeping his own records. This means, if they are written records, doing the writing, or using the tutor or volunteer as a scribe, as well as looking after them.

Here are some ways in which records can be kept:

Skills checklist

The student's learning objectives are translated onto a skills checklist which he then marks according to the level of confidence with which he uses particular skills (see Example 1).

Example 1: **Skills Check-List**

NAME OF STUDENT: Ian

DATE: December '81

Skill	Confident	No so confident	Can't cope
Addition and Subtraction of hours and minutes			✓
Subtraction of Hundreds, Tens and Units (H.T.U.)	✓		
Rounding up/down decimals	✓		
Division of H.T.U. by nos. up to 12		✓	
Reading specification chart in 'Car' Magazine		✓	
Depositing money at the bank			✓
Checking change at the petrol station	✓		
Using the library		✓	

Record sheet

The student answers the kind of questions posed in Example 2.

Free writing

Without the constraints of formal headings, the student writes about how he views his progress.

Audio and video tapes

Audio and video tapes can be used in several ways —

a) to avoid writing. Instead of filling in forms or writing descriptively, the student records his views on tape

b) to keep a record of performance in simulated situations

c) to keep a record of evaluative discussions involving the student and other people e.g. volunteer, tutor, other students. This could easily follow from (b).

Evaluation and Planning

Every time the student and tutor review progress some of the following are likely to happen:

i) a learning objective is discarded as having been fulfilled

ii) a learning objective is dismissed as being obsolete or irrelevant

iii) a learning objective is retained as only partially fulfilled

iv) a new objective emerges

v) a learning strategy is dismissed as being ineffective, cumbersome, or no longer needed

vi) a learning strategy is retained because it is effective

vii) a new learning strategy is proposed for a trial period.

The logical outcome of evaluation is planning. Examples 1 and 2, for instance, illustrate what one particular student is likely to be working on over the next month or two. Through careful evaluation, not only do new goals emerge, but also possible ways of tackling them.

Example 2: **Record Sheet**

NAME OF STUDENT: Ian

DATE: December '81

What work have you done since you last filled in a Record Sheet?

Subtraction of H.T.U.
Rounding up, rounding down decimals
Finding out how petrol pumps work
Division sums
Had a look at a chart in 'Drive'

How do you feel about the way your work is going?

OK. It seemed easy at first, but now things are slower.
I feel better knowing other people have the same problems.

What can you do now that you couldn't do before?

Subtraction of H.T.U.
Rounding up, rounding down decimals.

What do you still have problems with?

Division of H.T.U. sometimes.
24-hour clock.
Reading about cars.

What do you want to work on next?

More on division to make sure.
Want to spend most time on getting used to 24 hour clock and just telling time. Still do it in the old way.
More on reading magazines.

Reinforcing Newly Learned Concepts

If newly learned concepts are used to solve practical problems they will more likely be remembered. A theme used either by an individual or by a group can be a useful way to re-inforce concepts as it provides a practical use of the skill, whilst allowing an opportunity to use other skills the student possesses. As a group activity, a theme could be split so that sub-groups or individuals can pursue their own interests. Each could then be re-inforcing their own skills whilst working together on a group theme.

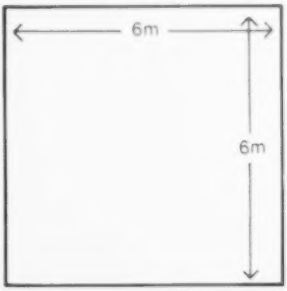
Three themes have been chosen as examples (gardening, dressmaking and travel). However, it needs to be remembered that themes should not be presented to a group as 'useful exercises' but need to arise out of a request or a demand from one or more of the group. Other themes might be sports results, buying new car tyres, choosing from a menu, or working out a journey by road. Some of the initial work may need to be carried out away from the group and information, catalogues, magazines, etc. may need to be collected.

	Activity	*Skill*
1. Gardening:	How big is the plot?	Measuring (metric)
	How many plants per row?	÷ decimals
	How many plants for the plot?	× decimals rounding up
	How much will plants cost?	× decimals, money, rounding up
	Can I afford it?	decisions
	Can I do it more cheaply?	(seed) catalogue comparison
	What will the return each year be?	estimation, weight, value
	Is it cheaper to buy plants or seeds allowing for harvest or take cuttings?	number recognition comparison

	Activity	*Skill*
2. Dressmaking:	Choose pattern size	number recognition measuring/reading chart
	Choose fabric	
	How much fabric?	chart reading
	Cost of fabric?	× money or rounding up (decimals)
	Total cost of materials?	+ money (decimals)
	Is it cheaper to buy?	comparison number recognition

	Activity	*Skill*
3. Travel	Cost of journey by public transport?	telephone/enquiry office
	Time of journey? Route?	24 hour clock
	Distance by car?	chart or map
	mpg of car?	÷ or known
	Amount of petrol?	÷
	Cost of petrol?	× decimals/money
	Time by car?	estimate or ÷
	Route?	map reading
	Conclusion?	comparison

Gardening



The plot is 6 metres long
by 6 metres wide

- ☐ How many blackcurrant bushes will fit in a row (6m)?
- ☐ How many gooseberry bushes will fit in a row next to them?
- ☐ How much would all the bushes cost?

Vegetables are grown next to the fruit.

One row and a half of potatoes are required, how many seed potatoes will I need?

Half a row of parsnips would be enough, how many parsnips do I need?

PLANT	How many?	How much?
Gooseberry		
Blackcurrant		
Potato		
Parsnip		

Part 2 Soft Fruit

		Each	Per 10
BLACKBERRIES			
Himalayan Giant		£1.25	£12.00
Merton Thornless		£1.70	£16.00
CURRANTS			
Black: Mendip Cross - early	Wellington XXX - mid-season	85p	£8.00
Baldwin - late	Jet - (new) late		
Red: Laxton No. 1			
White: Versailles			
GOOSEBERRIES for dessert or cooking	Keepsake - green, early	£1.25	£11.00
Careless - green, early	Whinhams Industry - red, mid-season		
Leveller - green, mid-season			
LOGANBERRIES			
Thorny (LY.59)		£1.75	
Thornless (LY.654)		£2.00	
RASPBERRIES			
Glen Cova (new) - early	Malling Promise - early		£1.50
Malling Jewel - mid-season	Norfolk Giant - late		
Zeva - Sept Self-supporting			£2.50
STRAWBERRIES Pot grown, not open ground runners			
1 Cambridge Vigour, 2 Cambridge Favourite, 3 Talisman — numbers denote order of cropping		40p	£3.70
Gento (new) Perpetual, mainly late summer		50p	£4.70
Grundi (Grandee) (new) very large fruits			

All the above are Self-fertile

When to Plant

Fruit	*Month*	*Distance Apart (Rows)*
Blackberries	October-March	2 m
Currants	November-March	1.5 m
Gooseberries	October-March	1 m
Loganberries	October-March	2 m
Raspberries	October-March	60 cm
Strawberries	Early autumn or March	45 cm

When to Plant

Vegetable	*Month*	*Distance Apart*	
		in rows	*between rows*
Onion	April	15 cm	30 cm
Parsnip	March	15 cm	45 cm
Pea	November	8 cm	
Potato	April-May	35 cm	80 cm
Rhubarb	November	1 m	

Harvest

The roots are ready for lifting when the leaves begin to die off in the autumn. Lift a few and store like carrots to use when the ground is too frozen for digging.

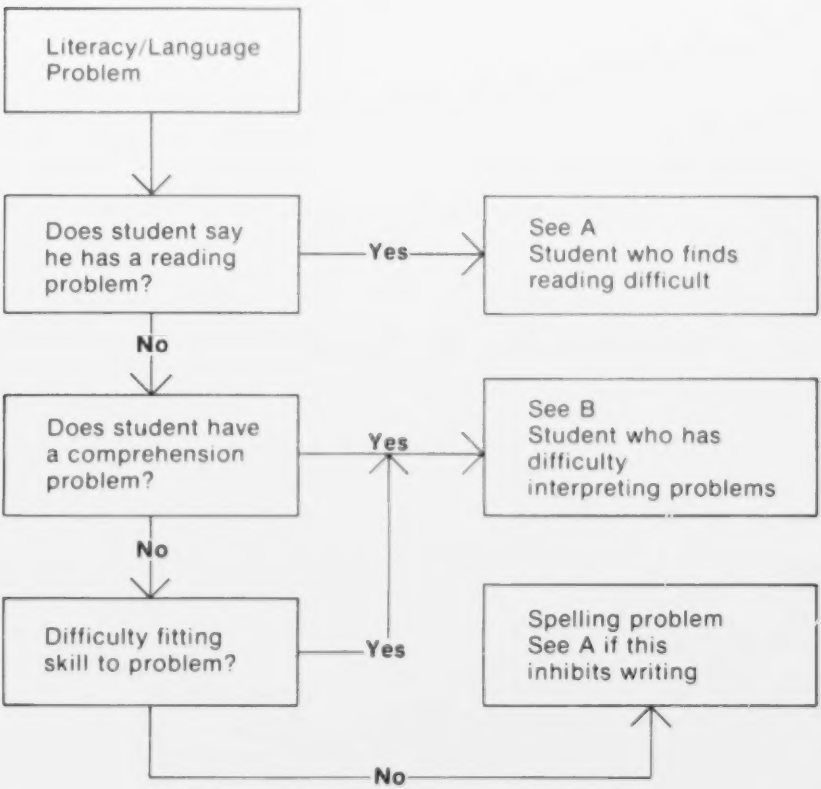
Pests and Problems

Parnips often suffer badly from a condition known as Canker. It appears as brown or black patches on the shoulders of the roots. There appear to be no effective control measures but experience has shown that early sowings are more prone to suffer than later ones. In the case of Parnsips therefore patience pays dividends so wait until well into April before sowing. The addition of lime to the soil and the practise of crop rotation also reduces the danger of infection.

Numeracy Students with Literacy and Language Difficulties

In the flowchart below an attempt is made to show the various types of literacy/language problems which may need to be taken into consideration when teaching numeracy.

A and B have been developed later in some detail giving general ideas and help with worksheet planning.



A. The numeracy student who finds reading difficult: some general points

How to find out

— from a literacy tutor making the referral
— from the interviewer
— by asking the student

Preliminary approaches

— talk/discuss with student
— try a few words, perhaps from a newspaper
— is he having help or wanting help with reading?

— let him know that it's a familiar situation
— put him at ease
— let him know he can get help with any reading.

Helping the student who can read very little

— talk to the student about
— starting with no words to worry about (just sums)
— having some words, but inaccurate reading won't affect the maths
— using words to match and get information
— using aids – cards, money, calculator
— improving literacy and numeracy together.

Other ideas

— tape recordings (of problems to support reading)
— using words the student knows
— other students to help with reading later
— problems in question form to be written clearly (ask a literacy tutor to help)
— games, eg. dominoes, cards, etc. to help group feeling.

Above all help the student to feel confident about doing some 'maths' – don't let a literacy problem get in the way of this. And remember that some students have a real aptitude for maths but find reading difficult.

A student with poor reading skills will need to feel confident before being asked to do numeracy work which also involves reading. Pages of

'sums' cannot be the answer, as although they may be of use when practising newly learned skills, they do not help the student apply these skills. Students who want practical help with handling money or measuring can begin with this and move on to carefully prepared worksheets containing a small amount of reading.

Here are some ideas for practical numeracy work by using worksheets with a controlled literacy content. These are based on a snack bar but may be applied to a range of topics.

SNACK BAR

Price List		**Drinks**	
Cheese on Toast	40p	Tea	13p
Beans on Toast	36p	Coffee	20p
Cheese Sandwich	30p	Squash	12p
Ham Sandwich	35p	Milk	12p
Cakes	20p	Coke	20p
Flapjacks	?		

Practical activities. These could involve discussion of what people actually buy and any problems they have handling money. (Use real money).

Practice estimating the cost of the snack.

- ☐ approximating amounts of money
- ☐ adding without writing it down

Practice giving the correct money

- ☐ knowing the value of each coin
- ☐ estimating the value of the coins in your hand
- ☐ counting coins – start with the largest value coin
- ☐ counting in 10's, and 5's and 2's.

Practice checking the change

- ☐ seeing relationship between amount paid, cost and change
- ☐ adding on method 'shopkeepers' subtraction NOT a written method.

Practice everyday activities

- ☐ "serving a customer"
- ☐ "buying a snack".

Worksheets

- ☐ provide notes for tutors; choose what is right for your student. Numeracy skills used – adding money, multiplying by small numbers (repeated addition).

1. Use *figures only* to avoid concern about working out numbers and reading together.

   25p
   +40p

2. Introduce words but reading them accurately need not be important

   e.g. coffee 25p idea of a bill
   cake 40p find total

3. Start referring to a price list – this can be done by *matching words*. Check students can do this – get them to fill in prices.

   e.g. coffee? tea?

   Set out small bills with prices missing – find prices by matching/reading

   e.g. coffee?
   tea?

4. Extend numeracy a little

   e.g. 4 coffees
   what is the change from £1.

5. Introduce simple written questions in easily read and remembered language.

   e.g. a cup of tea and a cheese sandwich. How much is that?

Example of Worksheet

Snack Bar

Read this price list

PRICE LIST

SANDWICHES

cheese 30p

ham 35p

egg 30p

HOT SNACKS

soup 20p

beans on toast 30p

cheese on toast 25p

egg on toast 25p

DRINKS

tea 13p

coffee 20p

milk 12p

orange 10p

hot chocolate 20p

coca cola 20p

Work out the **cost** of these orders and the **change**

ham sandwich
tea
Total **Change from £1 is —**

1 cheese sandwich
1 cheese on toast
2 coffees
Total **Change from £1 is —**

2 beans on toast
1 egg on toast
tea
Total **Change from £1 is —**

6. Student-prepared worksheets. e.g. perhaps a student or a group could make up a price list and some questions. This links the work with everyday life, boosts confidence and the bank of worksheets for other students.

7. Open-ended questions e.g. What could I buy for two people if I had £2?

Costing flapjacks

The numeracy involved in costing items for sale can be quite complicated and may involve fractions, decimals, weights and measures and percentages.

It is important for students who find reading difficult that the literacy involved does not become too complicated. Clear presentation of the information is important and it may be necessary to simplify some of the reading material. A tape recorder could be useful. Discuss ways of approaching the costing with the student. Check he can read and find the information he wants. He may also need help with writing as results will need to be recorded without being confused with each other. Organising worksheets so that all the words that will be needed can be copied is one way of helping with this. Making a chart with the student for recording the results can also help.

One method of laying out a worksheet to cost the flapjacks is shown on the next page. It assumes some help initially with the reading and layout and a discussion about how the problem can be approached. The numeracy involved includes imperial weights, proportions × and ÷ decimals and approximation. A general discussion about how items we buy are costed may also be useful, ie. how wages, salaries, production costs, administrative costs, transport, etc. can affect this.

B. The student who can read but has difficulty understanding the problem

Some students may have difficulty deciding on the appropriate mathematical skill to use whilst others may have a more general comprehension problem.

Some general points

Finding the information

- ☐ from the interviewer
- ☐ from the student 'I never know whether to add or multiply' or 'I could never do problems at school'

Example of a worksheet for student able to work at a higher level

Flapjacks

Recipe

8oz. oats
6oz. butter
3oz. syrup
3oz. Brown sugar
Pinch of salt

Cost of items

3kg (6.6 lbs) oats	= £1.80
1kg (2.2 lbs) butter	= £1.50
3kg (6.6 lbs) brown sugar	= £1.85
2.7kg (6 lbs) syrup	= £2.10
Cook's time	= £1.50 per hr.

3 × recipe = 50 flapjacks
and takes 1 hour to cook

	Oats	Butter	Brown Sugar	Syrup
	8oz.	6oz.	3oz.	3oz.
weight × 3	oz.	oz.	oz.	oz.
Cost of × 3	p	p	p	p

How much does it cost to make 50 flapjacks?

How much does it cost to make one flapjack?

Decide how much profit you will make on each flapjack (e.g. 5%).

What is the selling price of one flapjack after the profit has been added?

What is the profit on 50 flapjacks?

How many flapjacks must you sell to make a profit of £5.00?

- ☐ by observation of students work
- ☐ from discussion

How to begin

- ☐ discuss with the student the best way to help
- ☐ see if he can explain a problem involving numeracy
- ☐ see if he can explain something else he has read
- ☐ check he understands the skills he knows
- ☐ check the working of any written questions
- ☐ discuss numeracy.

Overcoming the difficulty

- ☐ give lots of practice choosing which skill to use, without having to do calculation
- ☐ talk through problems first
- ☐ set problems needing only simple calculations so that he can concentrate on interpretation
- ☐ start with a choice of two skills
- ☐ use real things or substitutes to aid work on problems
- ☐ encourage the student to visualise things.

Example

How many cassette racks can you fit on a shelf?

Discuss the problem. Visualise the racks or draw them. How could you work it out if:

- ☐ you had lots of racks
- ☐ you had 1 rack
- ☐ you were just given the lengths involved.

What arithmetic would you need to use?

Discuss the number of racks you would have if they were 3 racks high.

- ☐ discuss the skills needed here.

Dealing with Different Levels of Attainment in the Same Group

In most groups there will be differing levels of experience and attainment so a plan of work is required which will suit individual needs and yet not make members of the group feel completely isolated from one another. An effective way of doing this is by using a topic or theme. Work on the topic can be planned at different levels to suit individual needs (both of experience and attainment) with some tasks being general to the group as a whole.

Choosing a Theme

If possible the theme should be one which has arisen naturally – perhaps one of the group has expressed interest or difficulty in a particular topic and others in the group have said that it interests them. If a subject is not suggested by the group the tutor may suggest a topic she thinks is interesting or useful and assess reaction.

Discussion

Through discussion the tutor can find out the needs and skills of the group, ask for suggestions for a topic, work out a plan with the group and the group can sum up their achievements. The tutor might sum up this preliminary discussion by talking about the work she thinks worth developing and what different approaches to the topic can be planned at different levels to suit each member of the group. It is sensible mentally to allocate, before a lesson, specific material to specific students, or pairs, even if there has to be a change of plan

1. Use existing strengths of group members

A tutor might draw on the experience and knowledge of any member of the group perhaps to help make a worksheet – eg. a long distance driver can explain the workings of a tachograph and possibly produce a blank to make a worksheet on the 24 hour clock.

2. Variety of material

Have a wide variety of material

a) in type of resource available eg. – worksheets, books, possible sources of information outside teaching centre, use of pocket calculator, video tapes, organised visit.

b) in presentation of:

i. worksheets – check the format is interesting and varies from one sheet to the next.

ii. answers required from students – eg. written, verbal, graphical. (No one theme would necessarily use all these resources).

3. Liaison between individuals/pairs of the group

Apart from the subject matter itself, plan material so that though students may work on individual tasks, discussion is encouraged.

4. Relevance to the adult

Use adult terminology, pick examples from the adult world, eg. the world of work or D.I.Y.

5. The student who finishes quickly

Provide standby work for individual students who finish before others.

6. Work for the student who may not be involved in the theme

A student may have a specific short term goal such as passing a test, or he may want to concentrate on a particular aspect of learning. Others may not want to take part in what they might see as a distraction, although they may wish to join in some of the general discussion.

The number of sessions given to one theme is difficult to specify as it depends on many factors within the two general areas.

1. Material – If this consists mainly of worksheets, fewer sessions may be appropriate than if a variety of different types of material is being used.

2. Frequency and length of meeting – the group may meet once or twice a week, for 2 or 3 hour sessions or the students may be on a full time or substantial part time course.

It is important to discuss with the group approximately how many sessions the theme is likely to cover. A nervous, hesitant student may need the reassurance of no time limit and the tutor needs to take account of this. Others may choose to continue with an aspect of the topic after the rest of the group have decided to do something different.

Examples of some worksheets planned for work on V.A.T.

Worksheet	**before attempting worksheet**
Eg. 1. VAT now has to be included in the advertised price of all items sold at a café. The VAT still has to be calculated and the student is asked to do this using a calculator. Prices are carefully chosen to ensure simple working.	make sure student is confident at finding 15% using calculator and is able to round decimal figures up or down.
Eg. 2. Make out VAT invoices using a ready set out formula and prices. *Calculate* VAT.	make sure student is adept at working out 15% using a layout such as sub total + £36.42 10% + 3.64 5% + 1.82 15% + £5.46
Eg. 3. Use price list to find price of *one* of each item ordered. Then calculate: a. cost of the number ordered (and lay out invoice correctly) b. total cost of all items c. VAT at 15% d. cost to customer	

What is the Price?

You are working at a local café. The cost of each portion of food has been worked out and now 15% V.A.T. must be added. This is the price the customer will pay. Using a calculator find the 15%

e.g. Beans on toast **24p + 15% = 24p + 3.6p = 27.6p**
= 28p rounded up

Cup of coffee ..... 20p + 15% =

Cup of tea ..... 12p + 15% =

Glass of milk ..... 10p + 15% =

Glass of orange ..... 14p + 15% =

Yoghourt ..... 18p + 15% =

Sandwich ..... 32p + 15% =

Cheese on toast ..... 40p + 15% =

Bacon and eggs ..... 60p + 15% =

Sausages, peas and chips ..... 80p + 15% =

Mixed grill ..... £1.20p + 15% =

Video, Computer and V.A.T.

You work in the office of a firm which manufactures computer and video equipment. Complete the invoices set out below. Work out the V.A.T. as we have discussed (using the marked off section of each invoice).

1)

Cat. No.	Quantity Required	Description	Unit Price Excl. VAT £ p	Cost Price Excl. VAT £ p
DD14	1	Disc storage rack	300 38	
DC 5440	10	Disc cartridge	18 25	
Total =		VAT at 15%		
10% =		Total		
5% =				
15%				

2)

			£ p	£ p
PBB/B	10	Cassette tray	2 20	
CB/8	10	Cassette binder	5 24	
D. Cass/H	100	Cassette tapes	2 95	
Total =		VAT at 15%		
10% =		Total		
5%				
15%				

3)

			£ p	£ p
L3 S	1	Data safe	2.573 00	
LD S/2	3	Disc roll our shelf	32 63	
CL	1	Combination lock	154 89	
Total =		VAT at 15%		
10% =		Total		
5% =				
15% =				

Canteen Orders

You are responsible for the orders for your firm's canteen.

The canteen supervisor has handed you the following list of requirements. Use the Follows' price list and make out the necessary orders.

Set out your orders as below:

Description	*Quantity*	*Price per doz*	*Amount*
Pepsi Cola Babies	4 doz	0.93½	3.74
Fruit Juices 4 fl.oz.	12 doz	1.41	16.92
Roses Lime Juice 30 fl.oz	30 doz	5.30	159.00
			179.66
		VAT at 15%	26.94
			£206.60

January

3 dozen Pepsi Cola Babies
2 dozen Large Shandys
12 dozen Fruit Juices 4 fl.oz

March

20 dozen 7-UP splits 6 fl.oz
5 dozen Roses Lime Juice 20 fl.oz
2 dozen soda syphons
4 dozen Kia-Ora 20 fl.oz

May

10 dozen large shandy
15 dozen Schweppes Baby mins
30 dozen Pepsi Cola Babies
20 dozen Roses Lime Juice 30 fl.oz

July

100 dozen fruit juices 4 fl.oz
20 dozen soda syphons
30 dozen Cascade
50 dozen Suncrush

September

50 cases 7-UP, litre
5 gallons double strength Suncrush
35 cases 11½oz cans
12 dozen Roses Lime Juice 30 fl.oz

November

4 gallons bulk Lime Juice
12 dozen large shandy
30 dozen 7-UP splits 6 fl.oz

ANTONY FOLLOWS & SON LTD.

4 LANSCOMBE LANE
LONG DOWN
BRISTOL 2
Phone: 0272 42 3880

		PRICE PER DOZEN £						
		List Price Per doz	*Code 2 12-14 Cases*	*Code 3 15-39 Cases*	*Code 4 30-44 Cases*	*Code 5 45-99 Cases*	*Code 6 100-199 Cases*	*Code 7 200-300 Cases*
RETURNABLES								
Schweppes Baby mins	4 fl.oz	1.12½	1.07½	1.03	1.00	0.96	0.94	0.91½
Pepsi Cola Babies	4 fl.oz	0.93½	0.90	0.88	0.86	0.83	0.81½	0.81
Pepsi, Zing, 7-UP Splits	6 fl.oz	1.07	1.04	1.02½	1.00½	0.96½	0.94½	0.94
Fruit Juices	4 fl.oz	1.42	1.41	1.39	1.34½	1.28	1.26	1.25
Large Shandy		1.39	1.30½	1.28½	1.26	1.25	1.22½	1.16½
Soda Syphons		3.52	3.39	3.23	3.11½	3.01	2.95	2.89
Malvern Water		2.41½	2.31½	2.20½	2.13½	2.06	2.02	1.96½
NON RETURNABLES								
Schweppes Squashes and Cordials	26 fl.oz	4.63	4.45	4.30	4.22	4.06	4.00	3.92
Roses Lime Juice	20 fl.oz	4.26½	4.10½	3.83	3.78	3.76½	3.72½	3.67
Roses Lime Juice	30 fl.oz	5.93	5.70	5.52½	5.30	5.25	5.18½	5.11½
Kia-Ora	20 fl.oz	3.43½	3.31	3.09	3.04½	3.03	3.01	2.96½
Kia-Ora	30 fl.oz	4.67½	4.52	4.22	4.16	4.14	4.11	4.04
Suncrush	26 fl.oz	4.13	3.98	3.85	3.70	3.66	3.64	3.57
11½ oz Cans		1.73	1.67	1.67	1.63	1.63	1.63	1.63
N.D.B'S	8.8 fl.oz	1.46	1.41½	1.37	1.32	1.31½	1.30½	1.30
N.D.B'S	½ litre	2.65	2.57	2.49	2.39½	2.38	2.35½	2.52
7-UP	litre	3.61	3.54	3.53	3.53	3.52	3.50½	3.49
Cascade	26 fl.oz	2.31	2.16	2.16	2.16	2.16	2.16	2.16

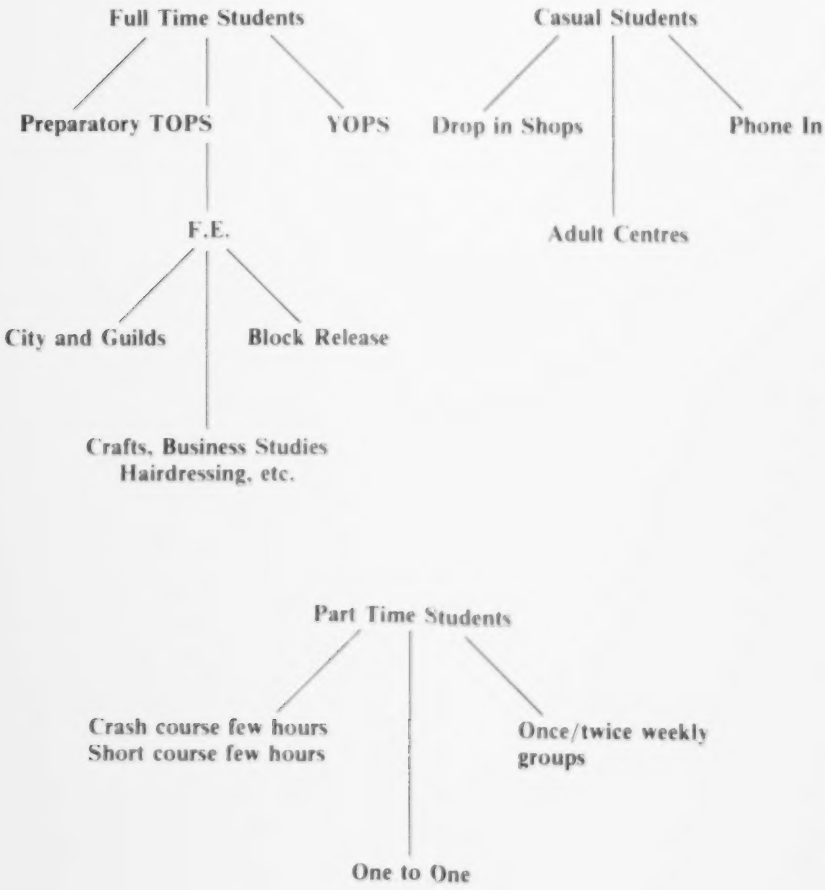
Bulk Lime Juice **£1.97 list price per gallon, excluding surcharge**

Double Strength Suncrush **£3.21 list price per gallon, excluding surcharge**

Prices are exclusive of V.A.T.

Numeracy Students with Limited Goals

Students wanting help with numeracy come with varying attitudes and expectations. Those involved in a full time course may differ in their outlook from students who have a specific request or a particular problem to solve. Often students with short term goals do not expect to undertake any sort of course.



Full Time Students

Numeracy may be just one component in a course, or students on a particular course may be confronted with a specific problem and request help from the tutor or – if available – from a college Maths Workshop. In many cases, students will see their difficulties as a stumbling block, either unexpected or all too familiar, and their attitude may be one of impatience or apprehension. Students may request 'first aid' explanations at first but later may find they need to have a fuller understanding of the problem.

Part Time Students

If a student attends a group or one-to-one for a short period he may find that others have similar problems and that he can start and stop where he likes. Other needs may arise which could encourage him to continue with numeracy for a longer period.

The Casual or Drop in Student

He usually needs to deal with his most pressing problem first although he may welcome the opportunity to drop in at any time if he wants to.

Some students may require help either with a particular part of an entry test for a course or job, including practice in the techniques of approaching a test. This can be covered in a 'crash course' when a student learns by rote but if he does not really understand he may find that:

- ☐ he is unable to apply the processes tested later in his course, and may fail the course
- ☐ he may forget how to apply or use each skill particularly if he has to wait for weeks or even months without any practice.

Estimation

Estimation features in most discussions about numeracy particularly in budgetting, going on holiday, D.I.Y., cooking and problems involving time and distance. Some students may not have realised that estimation is perfectly acceptable and the tutor may even have to point out how often we estimate every day in all kinds of situations. Students may not even equate these undoubted skills with numeracy at all.

Estimation is based on concepts involving number, space, time, distance and other types of measurement and involves carrying out quite complex calculations based on experience, memory, present information and an assessment of the level of accuracy required. It can save time and effort, contribute to decisions and forward planning and help to guard against mistakes. Yet it often appears to be accomplished almost without conscious thought or by intuition. Estimation and the ability to carry out mechanical skills are very different and students may have mastered one skill but still have problems with the other.

Some students may have specific estimating skills. For example,

- ☐ Experienced cooks can judge quantities such as flour, sugar, etc. and cooking time
- ☐ Building workers can estimate the amount of concrete, hardcore or bricks required to do a job
- ☐ Removal men can gauge the number of tea chests necessary to hold household goods and the amount a van can carry.

Here are some examples of estimating skills involved in different topics:

Shopping:	estimating cost of weekly shopping rounding up items to have an idea of cost both when shopping at different shops and before the check out
Budgetting:	estimating costs in different areas – household, fuel, clothes, saving money on shopping, leaving some money available for new items
Travel/ Holiday:	time – length of journey; time to depart and arrive, allowing for stops, etc. cost – rooms; campsite; food; spending money; space available in car, cases, etc. Weight that can be carried in car, plane etc.

Everyday: cost of upkeep of vehicle, use of bus, train, tube. Likely mpg for motorbike, car, driving/riding – reaction time to cross, overtake, relative speed, stopping time, etc.

D.I.Y.: cost of materials, amount of materials, time taken to do job.

Calculators

These can be useful tools, although it needs to be remembered that unless they are used correctly they will not produce the right answer. Therefore, you need to have some idea of the answer if you want to check the answer a calculator gives.

For example:

1. **If the amount owing is about £50**
   £52.48 is a reasonable answer but
   £524.80 is not reasonable.

2. **If the likely mpg for a car is 35 —**
   34.6 is a reasonable answer but
   64.6 mpg is not

3. **If the amount of oil and petrol used is about equal over a period of time:**
   either there is a mistake or
   the car needs a rebore.

Place Value

The earliest number systems were neither written nor spoken. A tally method was used for counting possessions, or fingers, pebbles or knotches on a piece of wood were used. Gradually, words were introduced to represent numbers – the first grouping of numbers to make counting easier was probably fives, i.e. a 'hand' or 5 fingers. Then 10, from 10 fingers, hence the word digit and today 10 is the base of most number systems.

The Concept of Place Value

Our number system 'collects' items in packages or groups of 10, i.e. base 10. Although most students can count at least up to twenty, they may not have a fundamental grasp of numbers or knowledge of place value. They may have no real concept of the principle of groupings of packages of 10 and this difficulty, often unrecognised by both students and tutors, may explain why some students produce unaccountable mistakes. They may also be unable to grasp the idea of decimals.

Mistakes to look out for

1. When writing down a two digit number, e.g. 27, a student may occasionally write 27 or 72 and be satisfied with either number.

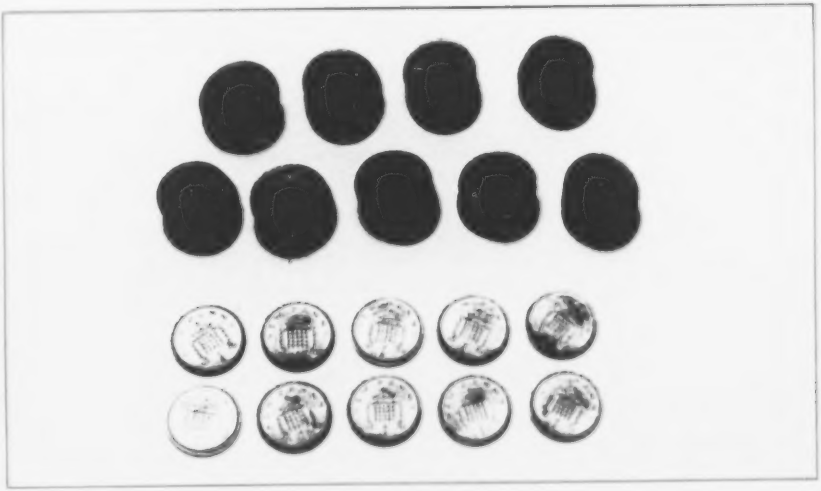
2. Students may make mistakes such as writing 301 as 3001, or put 200043 into a calculator for 2043. Such mistakes occur particularly where zeros are involved and may not appear except in those circumstances. As a check the tutor might casually ask the student to write down a number of three or more digits - given in words - containing a zero. The result is often revealing for both student and tutor.

3. A lack of understanding of place value may show up when the student is beginning to tackle decimals; the significance of the decimal point combined with uncertainty over the zero, both in whole numbers and decimal fractions often leads to confusion. The tutor may have to return to check place value and work through this before continuing with decimals.

Explaining the Concept

1. Money can be helpful in explaining the concept of 10's, or counting to 100. It is in everyday use and most students understand it, although a tutor may need to check that coins are recognised and their value understood.

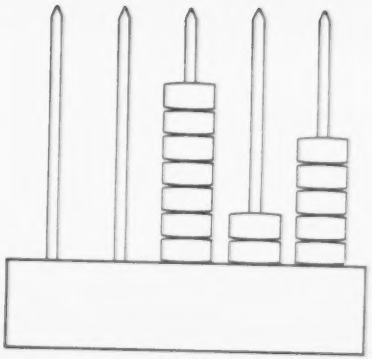
The packages of 100 can be set out:



Here are three different ways of packaging coins and notes which are of the same value, or stand for the same amount.

2. When the idea of 'packaging' has been discussed, an abacus is a very useful tool to explain the concept further and to demonstrate how vital is the place or position for the accepted value of the packages of 10. It can also introduce the difficult concept of zero.

A vertical abacus is shown on page 41. Although it is difficult to buy one it may be possible to make one, using thick wire or old knitting needles and 'odd cuts' of wood. Plain wooden beads may be bought or made.



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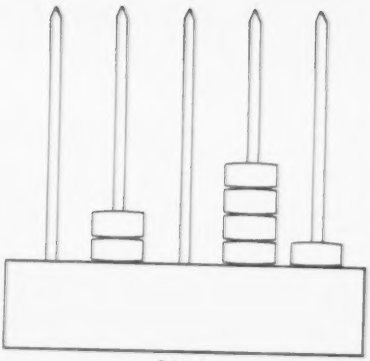


2041

When the spike or holder is full, (i.e. the 10th bead does not fit), the beads are removed and replaced by one bead the next holder along. This shows how the 'packages' are made up.

3. A digital counter such as that on a tape recorder can be useful, since numbers can be watched as they build up. The counter can be stopped at, say 109 and the student asked to predict the next number and then write it down. (Use the pause button). The counter is then restarted and the number checked. Other digital counters may be useful if they are available, e.g. old type office counters, knitting machine counters, mileometers, petrol gauges, etc.

4. If an abacus is not available, money can be used to build up the packages of 10, e.g. 10p = 1 10p piece and 10 lots of 10p pieces = 100 or £1, as mentioned in 1. (10 £1 = £10 note = 1,000 pence).

When a student has grasped the importance of the place of the package, he may find it helpful to make out a H.T.U. table to practice.

H	T	U
1	4	7
4	0	9
1	0	0
	3	5

The tutor might first introduce numbers excluding zero and then include zeros later when the student seems confident or the tutor and student can practice on a calculator, just keying in numbers correctly.

Addition

Place value leads naturally into the beginning of addition and the 'carrying' of a 10. It is better to deal with everyday articles rather than to use a textbook or school based approaches. A student might mention two or three things he has bought recently, e.g. a newspaper for 12 pence and a packet of peanuts for 15p.

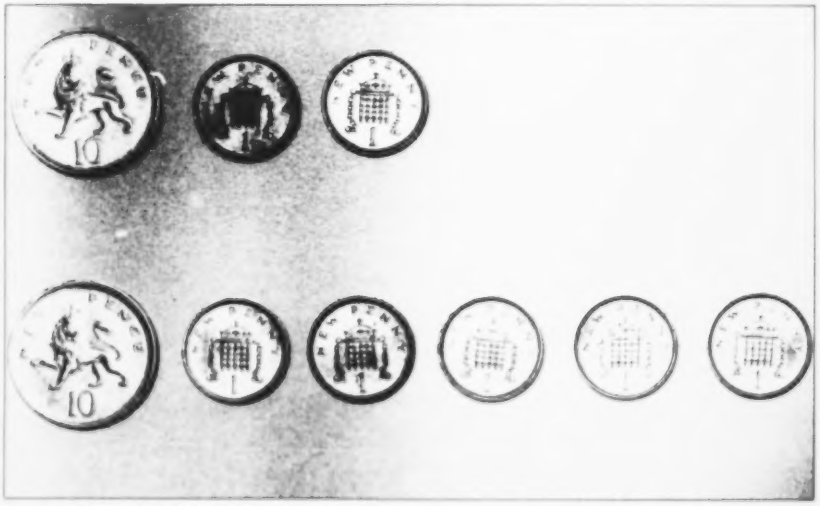
Note this will not involve a carrying figure.

The tutor puts the money down in two piles, one under the other.

12p – separated into one 10p piece and two single pence.

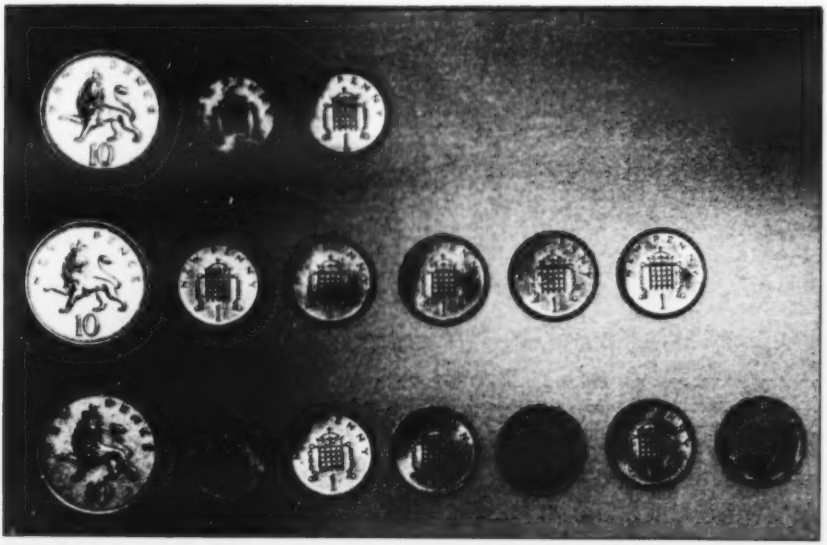
15p – separated into one 10p piece and five single pence.

Or



The student may well be able to do such a simple 'sum' in his head and the tutor might explain that it is an example to illustrate an important point or concept.

The next step is to add another purchase which will involve a carrying figure, e.g. a bar of chocolate for 16p. Add the 10p piece and the 6 pence to the other two.



This makes 3 10p pieces and 13 pence. 10p of the 13p can be packaged into a 10p piece making 4 10p pieces and 3p, or 43p.

It is easier just to deal with 10p pieces and single pence for this explanation. Other coins, such as 5p or 2p pieces may be confusing at the initial stage.

This whole process may appear extremely laborious. However, the student may not only have to learn a new concept, but have the added difficulty of clearing his mind of half remembered and confused thoughts. Once the carrying or re-packaging of 10's is understood, the student can begin more formal addition if he wants to as he should now have a firm basis on which to build an understanding of all the four rules, simple decimals and the metric system.

Number Bonds

When numbers are added symbols are used rather than objects or counters and for this it is necessary to memorise simple number combinations (eg. $3 + 4 = 7$) or to use an addition table for reference. Some people substitute fingers for counters, or jot down dots or dashes and then count them up. If a student does this, finds it slow, and is keen to find a new way, it is possible, with some guidance, to learn some of the simple number bonds by heart.

A student could work at the following:

Practice counting on with a number line such as a tape measure.

'Partition' a number
e.g. $4 = 4 + 0$ $4 = 3 + 1$ $4 = 2 + 2$ $4 = 1 + 3$ $4 = 0 + 4$

Find ways of getting to know the facts.

Practice counting on by completing these:

$8 + ? = 10$ $7 + ? = 10$ $6 + ? = 10$ $5 + ? = 10$ $4 + ? = 10$
$3 + ? = 10$ $2 + ? = 10$ $1 + ? = 10$ $9 + ? = 10$

Adding Small Numbers

- ☐ Students in a group discussion found 3 different ways of adding 7 and 8.

a) You need 2 to make 8 up to 10. Take 2 from 7, making 5. Add the 5 to the 10 – gives 15.

b) Two 7's are 14. Add 1 (because 8 is 1 more than 7) that gives 15.

c) Two 8's make 16. Take 1 off (because 7 is 1 less than 8). That gives 15.

- ☐ How do you add 9 and 6?
- ☐ Look at the numbers that add up to make 10 or less, first. Then go on adding any two numbers not more than 10 in value.
- ☐ Make some self-checking cards, eg. 4 + 5 on one side and 9 on the back.

Practice mental arithmetic when it doesn't matter if you get it wrong, eg. at home or in the group.	Practice adding and subtracting numbers on paper. The more you work with numbers the easier it should get.

Practice giving and checking change with somebody else using money. Try first with change from 50p and then change from £1.00.

Subtraction

Many people do all the subtraction they need in their heads. Change, if it were counted out would be something like this:

50p given to pay for an item costing 38p

So – '38p. Here's 2p, that's 40p. And 10p makes 50p'.

This is 38p 'up to' 50p or the use of complementary addition.

This method works well with time too.

10p Table

Change from £1				*To check change from £1*			
Money for payment		cost	change	Money for payment		change given	cost
£1.00	=	10p	+ 90p	£1.00	—	00p	= £1.00
£1.00	=	20p	+ 80p	£1.00	—	10p	= 90p
£1.00	=	30p	+ 70p	£1.00	—	20p	= 80p
£1.00	=	40p	+ 60p	£1.00	—	30p	= 70p
£1.00	=	50p	+ 50p	£1.00	—	40p	= 60p
£1.00	=	60p	+ 40p	£1.00	—	50p	= 50p
£1.00	=	70p	+ 30p	£1.00	—	60p	= 40p
£1.00	=	80p	+ 20p	£1.00	—	70p	= 30p
£1.00	=	90p	+ 10p	£1.00	—	80p	= 20p
£1.00	=	£1.00 (no change)	+ 00p	£1.00	—	90p	= 10p

Different people use different methods. It's surprisingly difficult for anyone to explain or 'talk through' what he is doing when it's a skill he has practiced for a long time – like swimming or cycling or even walking.

1. Sometimes subtraction is too difficult to do mentally. Time, for example, can be difficult, particularly working with 60 minutes in an hour and coping with a 24 hour clock. Most people manage in their heads and work to the next ½ or even ¼ hour, and this is fine unless you have to know exactly when, perhaps to catch a train connection and need to know how many minutes you have.

2. A student may be unable to work a sum on paper to check his wage slip.

3. He may need to pass a test.

So how does he subtract?

There are several ways to do this, not just the particular method the tutor happened to learn at school. In fact, many people over 35-40 years use one method – equal addition – whilst those under 35 usually subtract by decomposition. This is often why parents can't understand what their children are doing and vice versa. Each is correct, yet each thinks his method is *the* only right way.

Different students describe subtraction in different ways – taking away, 'going up to', minus or less than. They all come to much the same thing, but can be somewhat confusing.

Working it out

1. **Decomposition** often the method taught in schools

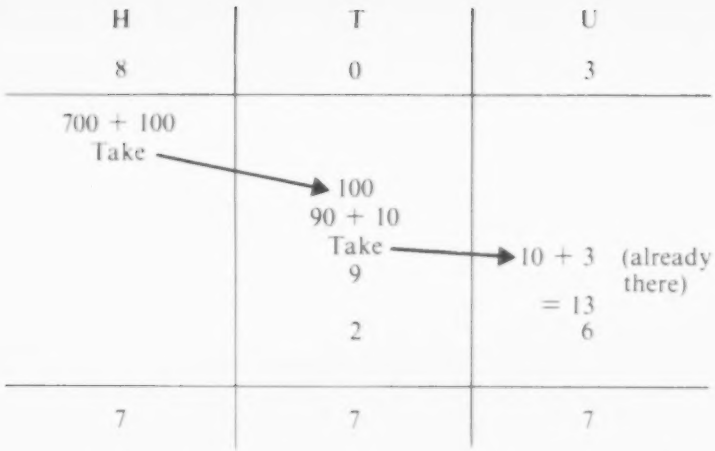
$$\begin{array}{r} 5\ 10 \\ \not{6}\ 2 \\ -2\ 8 \\ \hline 3\ 4 \\ \hline \end{array}$$

8 from 2 is impossible, so take a ten, leaving 5 tens. Then 8 from 12 leaves 4. Two tens from 5 (tens) leaves 3 (tens)

Taking (borrowing) 10 from a zero in decomposition can cause difficulties.

e.g.

	H	T	U
	8	0	3
−		2	6
	7	7	7



The student has to go to the 'hundreds' column before he is able to begin to 'borrow'.

2. **Equal Addition:**

```
   1
1+ 62
  -28
  ---
  34
```

You can't take 8 from 2 so borrow a ten*. 8 from 12 leaves 4. Pay back the ten in the 'tens'. 3 (tens) from 6 (tens) makes 3.

*Also 8 from 10 leaves 2. Add 2, this makes 4. Pay back etc.

BORROWING

Care is needed to take one 'ten' only.
To add it on as a 'ten' and not as a single number in the column.

PAY BACK

Care is needed in remembering to pay back
To pay back the right amount and
To pay back to the right figure.

eg.

H	T	U
3	¹2	¹1
1+1	1+5	4
1	6	7

Units: borrow a ten and this makes 11. 11—4 is 7.

Tens: Pay back to the 5. 6 from 2 you can't, so borrow a ten and this makes 12. 12—6 is 6.

Hundreds: Pay back the 1. 2 from 3 leaves 1.

These are the two most usual methods.

But what about these?

	62	28 is nearly 30, so 30 from 62 leaves 32. Add 2
	−28	because 28 was rounded up to 30 and the answer
	34	is 34.

or:	62	20 from 60 leaves 40. Take 10 from the 40, leaving
~~40~~	−28	30. Take 8 from 10 and this leaves 2. Add the 2 (of
30	34	the 62) and this makes 4. Answer is 34.

Variations of these methods – rounding up or down – are often used even with quite complex calculations. The larger the number, e.g. 321 − 54, the more likely are mistakes because of the growing complication and memory difficulties. If a student is using a method the tutor does not know and/or if the sum is wrong, it may be useful to get him to talk his way through the sum.

Mistakes

1. **Place Value:** Squared paper can be helpful.

e.g.

H	T	U
4	7	6
−1	3	0
3	4	6

But it won't help with

476 − 130 =

Mistake might be

476
− 13

This format is often met in tests and students need to be aware of and practice it.

2. A mixture of decomposition and equal addition may provide interesting if incorrect results! It can sometimes be helpful if the student tells the tutor how he has worked out the sum.

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3. Not being able to borrow or pay back, i.e. a zero often causes difficulty. Here, using 10p pieces and 1p and maybe £1 notes can be helpful in illustrating the conversion of powers of 10.

4. Rounding up and down methods may produce accurate answers in tens and units and even in hundreds. After discussion a student may choose to continue with this method which he feels to be adequate for his particular needs, or he may decide to learn either decomposition or equal addition. Some students will manage this quite easily, if they already have a good concept of subtraction. Others may become confused even after initial success with the new method.

Multiplication

Multiplying is a quick way of adding numbers that are all equal. Most students have a method to work out, say, the cost of 5 cups of coffee, even if the answer isn't correct. Some will add the price five times, some will double it, double it again and then add the price, and others will use some other strategy.

Multiplication Tables

Students often say they want to learn 'tables' and it certainly speeds up calculations if the basic multiplication facts, say to 10, are known. However, it shouldn't be assumed that everyone who wants to do some multiplication needs to learn 'tables'. Speed may not be necessary or they may have a calculator.

A tutor can check that a student understands the concept of multiplying by relating it to adding.

Show that $6 + 6 + 6 + 6 = 4 \times 6 = 24$
and $4 + 4 + 4 + 4 + 4 + 4 = 6 \times 4 = 24$ } by using coins, matchsticks, etc.

Once this is understood, the student can be shown how to use a multiplication square, or written multiplication tables for reference.

Multiplication square or written tables?

A multiplication square is a compact aid:

1	2	3	4	5	6	7	8	9	10
2	4	6	8	10	12	14	16	18	20
3	6	9	12	15	18	21	24	27	30
4	8	12	16	20	24	28	32	36	40
5	10	15	20	25	30	35	40	45	50
6	12	18	24	30	36	42	48	54	60
7	14	21	28	35	42	49	56	63	70
8	16	24	32	40	48	56	64	72	80
9	18	27	36	45	54	63	72	81	90
10	20	30	40	50	60	70	80	90	100

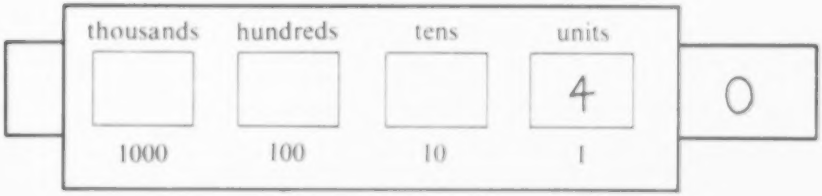
- ☐ it helps to develop a skill which can be transferred to other tables, e.g. timetables;
- ☐ it helps in showing $4 \times 5 = 5 \times 4$ etc;
- ☐ however it needs care to avoid misreading.

Multiplying by 10

When you multiply by 10, a 0 is often the last figure. If you add 10s vertically, this shows why:

e.g. 10
10
10 is 4×10
10
40

The 4 is now in the tens position representing 4 tens and a 0 is necessary as a place keeper. A simple aid can be used to demonstrate this. It consists of a double piece of card open at the ends and with spaces for numbers and a strip with the numbers required.



To multiply by 10, move the paper strip so that the 4 shows in the tens position, a zero must be written in to fill the empty space.

Some ideas for learning tables

- ☐ make it a gradual process
- ☐ learn a few facts at a time
- ☐ start with the easiest - 2 and 5
- ☐ start from what the student knows
- ☐ show the small number of table facts needed

$2 \times 2 = 4$
$3 \times 2 = 6$
$4 \times 2 = 8$
$5 \times 2 = 10$
$6 \times 2 = 12$
$7 \times 2 = 14$
$8 \times 2 = 16$
$9 \times 2 = 18$
$10 \times 2 = 20$

$3 \times 3 = 9$
$4 \times 3 = 12$
$5 \times 3 = 15$
$6 \times 3 = 18$
$7 \times 3 = 21$
$8 \times 3 = 24$
$9 \times 3 = 27$
$10 \times 3 = 30$

$4 \times 4 = 16$
$5 \times 4 = 20$
$6 \times 4 = 24$
$7 \times 4 = 28$
$8 \times 4 = 32$
$9 \times 4 = 36$
$10 \times 4 = 40$

$5 \times 5 = 25$
$6 \times 5 = 30$
$7 \times 5 = 35$
$8 \times 5 = 40$
$9 \times 5 = 45$
$10 \times 5 = 50$

$6 \times 6 = 36$	$7 \times 7 = 49$	$8 \times 8 = 64$	$9 \times 9 = 81$
$7 \times 6 = 42$	$8 \times 7 = 56$	$9 \times 8 = 72$	$10 \times 9 = 90$
$8 \times 6 = 48$	$9 \times 7 = 63$	$10 \times 8 = 80$	
$9 \times 6 = 54$	$10 \times 7 = 70$		
$10 \times 6 = 60$			$10 \times 10 = 100$

Written multiplication

Examples

Start by multiplying by a single number with no carrying figure.

$$\begin{array}{r} 23 \\ \times\ 3 \\ \hline 69 \end{array}$$

Go on to include a carrying figure and show the similarity to adding.

$$\begin{array}{r} 23 \\ \times\ 5 \\ \hline 115 \end{array}$$

Practise this skill with some useful applications

Multiplying by 20, 30 etc.

20 can be read as two 'lots of' 10 or 2×10 and 30 as 3×10 and so on.

Long multiplication

Show that to multiply by, say 23, you need to multiply by 20 and by 3, both of which the student has already mastered.

There are a number of ways of laying out a long multiplication so if the student has a half learned method, build on that. Some people multiply by the unit first, others by the tens (or hundreds).

26×23
$= 26 \times 20 + 26 \times 3$
$= (26 \times 10 \times 2) + (26 \times 3)$

$$\begin{array}{r} 26 \\ \times\ 23 \\ \hline 78 \\ 520 \\ \hline 598 \end{array} \qquad \begin{array}{r} 26 \\ \times\ 23 \\ \hline 78 \\ 52 \\ \hline 598 \end{array}$$

$$\begin{array}{r} 26 \\ \times\ 23 \\ \hline 520 \\ 78 \\ \hline 598 \end{array} \qquad \begin{array}{r} 26 \\ \times\ 23 \\ \hline 52 \\ 78 \\ \hline 598 \end{array}$$

Common mistakes

When multiplying by zero.

Carrying wrong figure.

Forgetting about starting in the 10s column when multiplying by 10, 20, etc.

Multiplying the figures in some unusual order.

Practice the skill

An immediate practical use for multiplication is in calculating areas and this can also reinforce what is meant by multiplying. Home decorating, buying floor covering and DIY all provide useful work.

Division

Division is repeated subtraction and is a convenient quick way to perform it. It can be demonstrated with real objects but the process is long and is therefore abbreviated by subtracting in larger groups. A knowledge of multiplication is necessary in order to use the method of writing it on paper.

1. **Simple concrete beginning**

	Results
a) Share a variety of things, cut others into parts, divide similar objects between you	
b) Share 40p (4 × 10p) between 4	4 coins ÷ 4 = 1 40p ÷ 4 = 10p
c) Deal a pack of cards to 4 people	52 ÷ 4 = 13 or $4\overline{)52}$ 13

2. **Develop the level of difficulty gradually**

a) Deal out the cards between 3 people. The one left over can only be left over (a remainder) and is a good example of the frequency of remainders	$3\overline{)52}$ 17 R1

b) Buy 2 lbs of potatoes costing 15p. Share the coins into two piles perhaps saying how many 2s in 15, and change the remaining penny into two ½p coins.

$$2\overline{)15p}\quad 7\tfrac{1}{2}p$$

c) Introduce an example where the remainder is treated as a decimal. £6.00 for 4 hours work – how much per hour?

Share out pound notes and change the remainder into coins.

$$4\overline{)6.00}\quad 1.50$$

3. **Long Division** is a skill which is rarely needed. If it must be taught use small digit numbers, e.g. 21, 32, whose products can be more easily calculated. The process is long and tedious, although a student might use a calculator to check the answer is sensible.

Every tutor and student needs to decide whether this particular skill needs to be learned and to what level of difficulty it needs to be taken as there are not many times when division in a written form is needed.

The setting out may vary according to a student's previous experience and background. In long division, particularly, there is no reason why first inexact attempts need to be discarded – the answer could be split.

for example: if I earn £3,962 p.a. how much a week would I get?

3962 ÷ 52 (or by 50 if an accurate answer is not thought to be necessary)

00??	How many 52s in 3?	0
52 | 3962	How many 52s in 39?	0
	How many 52s in 396?	I know that $6 \times 5 = 30$
	So perhaps 6 52s are in 396?	

$$52\overline{)3962}\quad 00\overset{1}{6}6$$

312	
84	There's another 52 in this so take another away.
52	
322	32 tens and 2 = 322. Use what I already know
312	viz $6 \times 52 = 312$
10	Do I want a fraction or decimal answer?
	Treat the remainder accordingly.

(1)(6)
0076 R10
52 | 3962

6 tens and 1 make 7 tens, i.e. 76

Mistakes

1 (a)
39
3 | 927
— no place keeping 0 used.

(b)
31 r1
3 | 931
— no place keeping 0

(c)
21 r1
17 | 3589
— missed a figure

Tidy working with squared paper at first helps to avoid these mistakes.

2 28 ÷ 3

28 | 3

Lack of understanding of symbols and accompanying language.

Fractions

All of us know something already of fractions in everyday life and every tutor can make students aware of this.

Ascertain the need for fractions:-

- for calculations at work
- to be able to help their children
- to pass a test
- for proportion calculations

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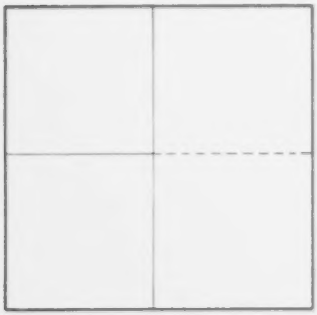
Explain the general limited use of fractions — at the most $\frac{1}{4}$, $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{6}$, $\frac{1}{8}$, $\frac{1}{5}$, $\frac{1}{10}$, $\frac{1}{20}$

- that it is shorthand
- that it is division
- that although a fraction of a whole, it can be a large number: e.g. $\frac{1}{4}$ of a pack of cards consists of 13 cards
- that the top number says how many parts there are and the bottom number is the name of the part (i.e. avoid 'numerator' and 'denominator')
- that there are two groups of fractions skills — addition/subtraction and multiplication/division; try to work with this grouping and stress that basically there are two approaches.

Adding/Subtracting

Practical work is important — use real things, where appropriate, fruit, bread, paper, card. Some practical help may be needed each time. For some students the use of card and scissors once or twice will be sufficient and these are useful also for equivalent fractions. As practical work is done, the written form can appear alongside so that it becomes familiar.



one quarter and one half
$\frac{1}{4} + \frac{1}{2}$

one half is two quarters
$\frac{1}{2} = \frac{2}{4}$

One quarter and two quarters are three quarters
$\frac{1}{4} + \frac{2}{4} = \frac{3}{4}$

The words accompany the reality, the figures represent the words.

Where fractions larger than one are used, the whole numbers can be dealt with separately leaving the fractions as before. This applies to addition and subtraction.

e.g. $3\frac{1}{8} - 1\frac{1}{4} = 3\frac{1}{8} - 1\frac{2}{8} = 2\frac{1}{8} - \frac{2}{8} = 1\frac{9}{8} - \frac{2}{8} = 1\frac{7}{8}$

This method, which is called decomposition, ensures smaller numbers which are easier to handle.

Multiplying and Dividing

Lots of simple examples are needed first so that it is clear that multiplying does not always give a larger result and dividing a smaller result. This seems to enable division (the 'change the ÷ sign to × and turn the next fraction upside down' rule, which most tutors learnt) to be more reliably remembered. After this division is the same process as multiplication and so should not present new problems.

Another idea which needs to be stressed is that all mixed numbers should be turned into top heavy fractions in order to multiply or divide them.

Remember why the student wants fractions – don't get carried away by the fractions.

Here are some suggestions to help a student who needs to pass a test.

Adding and Subtracting

Use the earlier general introduction to fractions to consolidate the idea of equivalence viz ½ is also 2 quarters, ⅓ is also 2 sixths, ¾ is also 6 eighths, or ½ is the same as ⅜ is the same as $^5/_{10}$ is the same as $^4/_8$. All of this can be done practically and then written

e.g. $\frac{1 \times 5}{2 \times 5} = \frac{5}{10}$

Equivalent fractions are an important stage in the addition and subtraction processes. The choice of which equivalent fractions to use is determined by looking at those involved. Once the choice has been made, a common denominator appears.

Multiplying and Dividing

$3 \times ½$	½ of 3
3 halves = $1½$	half of 3 = $1½$
$3 \div ¼$	$¼ \div 3$
how many ¼s in 3 = 12 (bigger)	¼ divided by 3 = $^1/_{12}$ (smaller)

Notice the language changes according to example – some are more suitable than others. Students might practise writing the question in fraction form and reading the fractions in the most suitable way. Start from real situations whenever possible.

¾ of a yard? Find out what it actually is and then look at the way it's represented on paper.

¾ of 1 yard = ¾ × 36 inches.

Use money to help students to see that division of fractions is not a trick.

How many halves (½p) in 5 (p) = 10

What did you actually do – exchanged each 1p for 2 × ½p or 2 halfpence.

5 × 2 = 10

(6 × ½ and 6 ÷ 2 give a similar situation)

Decimals

It does not really seem to matter whether a student learns decimals or fractions first. Generally build on what a student knows, or whichever arises first. The fact that decimals are the written form of tenths, hundredths, etc. forms the link between the two. It is not difficult to introduce decimals as they follow logically from whole numbers, or from place value. They can then be written as fractions and simplified eg. 0.4 = $\frac{4}{10} = \frac{2}{5}$. Keep them simple to start with and the fraction operations will follow naturally.

When a student is already familiar with fractions, equivalents may be used as the lead in to decimals, for example, $\frac{1}{2} = \frac{5}{10} = 0.5$. Though the ordering of fractions/decimals is not rigid, either or both should be taught before percentages. Decimals are used increasingly. They are an extension of our number system and although another way to write or express fractions, they are often easier to manage on the whole as compared with fractions.

Decimals are needed:

- ☐ for money
- ☐ for measuring in the metric system
- ☐ for tests

Although money is decimal, the language of money does not transfer to all metric units, although it sometimes helps to use money at the beginning.

For example, 2.53 is two point five three. Put the £ sign in front and we say two pounds, fifty three (pence).

Again, 3.5 is three and half, but may be read 3 point 5.

Three and a tenth is 3.1 but may be read 3 point 1.

The point indicates the end of the whole numbers and the beginning of the parts.

Any whole number may be written with a point but a 0 must follow it, showing that there are no parts.

Adding and Subtracting

In groupings of 10, both addition and subtraction keep the decimal point in the same position.

Multiplying and Dividing

a) by whole numbers, the method is similar again, the point remaining in the same position.

b) by ten, hundred, thousand – use the simple aid (described on page 51) both for multiplying and dividing. By moving the paper strip the figures move to make a larger number when multiplying, and to make a smaller number when dividing. (This avoids general confusion about whether to move left or right!)

   You can practice this with metric units.

   e.g. a 75cl wine bottle might be re-calibrated to ml or l.

c) by decimals – the ability to multiply by ten, one hundred etc. is an important skill for this.

No-one knows their decimal tables so everyone converts the decimals to whole numbers.

e.g. 3.5 metres of fabric at £2.45 a metre.

2.45 × 3.5	make all the numbers into whole numbers × 100 and × 10 – use the aid. (see p.51)
245 × 35	
	Proceed as usual.

245 ×
35

1225
7350

8575

Now make the decimal again by ÷ by 100 and ÷ by 10 (exactly the opposite of the above).

Use the teaching aid (see page 51)

÷ 100 85.75

÷ 10 8.575

Total cost £8.57½p

Many students half remember the 'rule' – the number of places after the point in the answer must be the same as the total number of places after the point in the question. An alternative to this would be to treat the numbers as though there were no decimals – 8575 being the result. The size of the answer can be worked out (with some exceptions) from the original information. 3 metres at £2 would cost £6, so the result should be less than 10. 8575 can only be 8.575 to be less than 10 so the point must go after the 8.

There are few real-life occasions when decimal division is used, most are changed immediately into whole numbers thus avoiding the decimal operation (e.g. money). However, for many tests the skill is required.

Decimal division for tests

It is always necessary to make the divisor (number dividing by) into a whole number by multiplying by ten or a hundred etc. The number being divided must then be multiplied by the same (viz ten, a hundred) as above.

e.g. $3.5\overline{)42.7}$ becomes

$35\overline{)427}$

both are multiplied by 10.

It is important to demonstrate to students that having multiplied both numbers by ten or a hundred and having obtained an answer, there is no need to divide by that ten, hundred etc. This may be done practically (with money perhaps) or on paper thus:

The sum is:

$.3\overline{)3}$ a) $3\overline{)30}$ (10) b) $30\overline{)300}$ (10)

The answer obtained in each sum is the same because the numbers have both been increased by 10 in a) and increased by a hundred in b).

Percentages

Percentages are used to generalise about all sorts of things, be it unemployment levels, wage rises or success in exams. They are also used where money changes hands, as a service charge, as VAT, as a discount or as interest.

Per cent means out of a hundred and so 1% means one in a hundred, or 1p in the £1. As a rule of thumb, this is indispensable.

That 100% is the whole may seem obvious, but an increase of 150% is more difficult to understand.

There are three main groups of percentages.

1. Those which give a known (recognised) fraction when simplified
   e.g. 50%, 75%, 20% ($\frac{1}{2}$, $\frac{3}{4}$, $\frac{1}{5}$)
2. Those which are multiples of 10%
   e.g. 30%, 70%, 20%
   (find 10% and work from there)
3. Those which do not simplify:
   e.g. 13%, 24%, 69% (find 1% first and work from there).

It is often enough to approximate.

For example, VAT on a bill is 15% or about $\frac{1}{6}$ of the total amount, so it may be easier to divide by 6 as a rough check. 30% is almost $\frac{1}{3}$ so here the total can be divided by 3.

Cautionary Note

When using a calculator to find a percentage, be certain students know the correct procedure for the particular calculator, i.e. if there is a percentage key, the procedure for using this key.

Measurement

Measurement involves practical mathematics and observations of everyday life. Measuring has within it a sense of 'doing something' which will, hopefully, break the all too prevalent emphasis on mathematics as the manipulation of figures on paper.

Measuring also gives instant results which can be easily checked and is often the information collection stage of solving a problem, since one needs to know what to measure, how to measure it and then how to use this data to solve the problem.

Here are some points to bear in mind when teaching measurement:

- ☐ Emphasise the practical application of measurement e.g. working out the wallpaper for a room or material for curtains.
- ☐ Make sure the student understands the concepts of measurement – smaller than, heavier than.
- ☐ Check he can use the vocabulary of measurement with understanding and confidence e.g. how long is an inch, how heavy is a kilo? What is area? Can he define these in his own words with reference to reality. It is easy continuously to define units of measurement in terms of other units, e.g. an inch is 2.54 cms without really having a picture of 'inchness'.
- ☐ Can he use the tools of measurement with confidence – scales, rulers, tapes?

Estimation and Approximation

- ☐ Estimation is an element of measurement that we all use, albeit sometimes unconsciously.

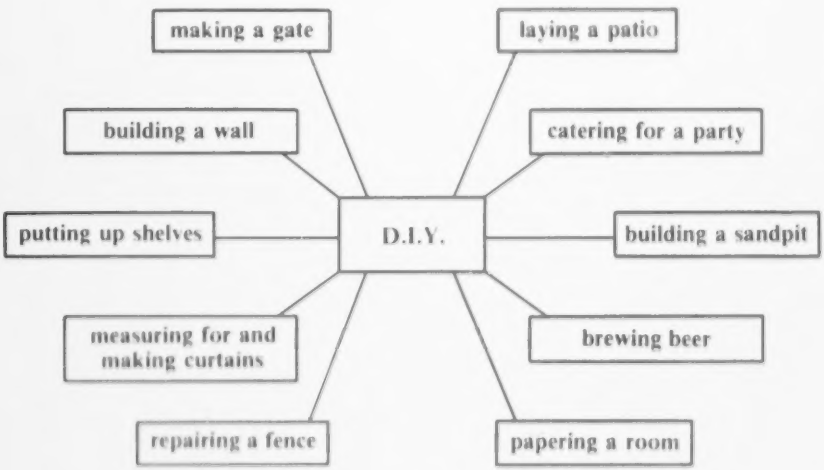
  Often estimation is sufficient e.g. when choosing a bowl for baking, or estimating the size of a parking space. It doesn't have to be precise, as long as it is lärger than you require, the exact measurement is irrelevant.
- ☐ Practice in estimation is a valuable exercise e.g. How long is the room? How tall is that man? How much does the parcel weigh?
- ☐ Having the confidence to estimate the answer, in measurement or any other element of mathematics, helps in recognising an error in calculations – a man couldn't possibly be three metres tall.

Confidence in measuring is built through practical use. Encourage students to define concepts in their own words – to explain how heavy or how long something is in their own way, and then in conventional units.

Many people still find difficulty in picturing a man 1.9 metres tall. A man of 6ft 2ins is easier – only because of the familiarity with the length of a foot. Conversely young adults may have only learnt metric measurement at school and could be unfamiliar with imperial measurement.

Below is an arbitrary list of practical tasks involving measurement. Any task done by the student could be worked through as teaching material.

The example below is based on D.I.Y. It demonstrates the many different practical tasks which involve measurement of all kinds.



An example of the way a practical task—here making a sandpit—involves measurement plus several other types of skill, is shown overleaf. It could form the basis of work with an individual student or a small group.

Making a Sandpit

Skills Used

Estimation
Four rules
Length
Area
Volume/cubic capacity
Money
Time
Simple fractions (add/subtract)

3 bricks?
up to his knees?
12 inches?
How deep do I want it? or how deep (wide) is the wood I have and want to use?
How big a space is there?
How long do pieces of wood need to be to go round that space?
SANDPIT
Draw plan of area
How many screws?
— roughly
— a dozen?
— a gross?
Roughly about how large will it be?
— 2 arm widths
— so John can lie stretched out?
— above 6ft or
— 2 metres?
Estimation of time it will take
How much sand do I need to buy?
— a large sack?
— a cubic metre?

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Kingsbourne House, 229-231 High Holborn,
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